International Science and Technology Journal
المجلة الدولية للعلوم والتقنية

Volume32 العدد
Part 2 المجلد
July 2023 يوليو

المجلة الدولية للعلوم والتقنية
International Science and Technology Journal
ISTJ

تم استلام الورقة بتاريخ: 2 / 2023/7م وتم نشرها على الموقع بتاريخ: 31/ 7 /2023م

Artificial Lift Selection and Optimization for Well E-25 in (103-E) Intesar Field, Sirt Basin, Libya

Ibrahim Aldukali [1], Ziyad. Ben Abdulhafid[2], Ayad M. Elkordi[3], Mohamed A Soltan[4], Mohamed. H.Targhi[5]

[1]Petroleum and gas Engineering Department, Sebha University, Libya
[2]Petroleum Engineering department, College of Applied Sciences, Technology- Al-Awata-
[3]petroleum department, Mellitah oil & gas company Tripoli- Libya
[4]Geophysics & geology department, Mellitah oil & gas company Tripoli-Libya
[5]Geologist & geology department, Mellitah oil & gas company Tripoli-Libya
Ibr.aldukali@sebhau.edu.ly, z.benabdulhafied@gmail.com, aelkordi@mellitahog.ly, mohamesultan80@gmail.com, mhmtarghi@gmail.com

Abstract

This study focuses on the artificial lift selection and optimization for Well E-25 in the (103-E). Intesar Field, Sirt Basin, Libya. Reservoir characteristics and production history analyzed to determine the most suitable artificial lift method. Gas lifting and electric submersible pumps (ESPs) evaluated. Production has been simulated in PROSPER software for different scenarios and methods. The results indicate that gas lifting offers simplicity and can be optimize through completion design, while ESPs have a limited lifetime, increasing project costs. The production analysis of Well E-25 demonstrates the superiority of the ESP solution, which can also enhance production and recovery factors for the field. However, gas lifting can be advantageous with efficient water injection management, resulting in increased fluid production and maintaining pressure and water cut. Gas lifting may be a cost-effective choice when multiple wells use this method.E25 well's performance curve graph shows that the operational point's liquid flow rate is 999.5 stb/d. The gas lift performance curve also shows

تم استلام الورقة بتاريخ: 2 /2023/7م وتم نشرها على الموقع بتاريخ:31/ 7 /2023م

that liquid flow rates are 875.5 stb/d.

Keywords: Artificial lift, gas lifting, electric submersible pump, production analysis, PROSPER software, Intesar Field, Sirt Basin, Libya

"اختيار الرفع الاصطناعي الامثل للبئر E-25 في الامتياز (E-103) حقل الانتصار، حوض سرت، ليبيا"

[1]ابراهيم الدوكالي ،[2]زياد علي بن عبد الحفيظ،[3]عياد الكردي، [4] محمد علي سلطان، [5] محمد التارقي

قسم هندسة النفط، والغاز بكلية الهندسة جامعة سبها، ليبيا.[1]

قسم هندسة النفط، بكلية التقنية للعلوم التطبيقية العواتة، ليبيا.[2]

قسم نفط، بشركة مليتة للنفط والغاز ، ليبيا.[3]

قسم الاستكشاف، بشركة مليتة للنفط والغاز ، ليبيا. [5,4]

الملخص

تركز هذه الدراسة على اختيار آلية الرفع الاصطناعي وتحقيق المستوى الأمثل في البئر. E-25الواقع في حقل الانتصار (E-103)، حوض سرت، ليبيا. وقد تمت عملية تحليل خصائص المكمن وتاريخ الإنتاج للبئر و ذلك لتحديد أنسب طريقة للرفع الاصطناعي. وقد جرى تقييم الرفع بالغاز والمضخات الكهربية الغاطسة. تمت محاكاة الإنتاج في برنامج PROSPER لسيناريوهات وأساليب مختلفة النتائج المتحصل عليها تشير إلى أن طريقة الرفع بالغاز يتيح البساطة ويمكن الوصول به إلى المستوى الأمثل من خلال تصميم الأمثل، في حين أن نظام المضخات الكهربية الغاطسة ذات عمر محدود مما يزيد من تكاليف المشروع. ويُظهر تحليل الإنتاج الخاص للبئر E-25 أن طريقة الرفع بالغاز يمكن أن تكون مفيدة مع الإدارة الكفؤة مما يؤدي إلى زيادة إنتاج الموائع والمحافظة على الضغط وتقلل قاطع الماء المصاحب المنتج مع النفط. وقد يكون الرفع الغاز خياراً فعالاً من حيث التكلفة عندما تستخدم الآبار المتعددة لهذه الطريقة.ويبين الرسم البياني لأداء البئر

تم استلام الورقة بتاريخ: 2 / 2023/7م وتم نشرها على الموقع بتاريخ:31/ 7 /2023م

E25باستخدام ESP أن معدل التدفق السائل عند الظروف التشغيلية هو 999.5 طن متري/يوم. ويبين منحنى أداء التدفق باستخدام الرفع بالغاز أيضاً أن معدلات التدفق السائل هي 875.5 طناً مترياً / يوماً.

الكلمات المفتاحية: طرق الرفع الصناعي – الرفع بالغاز –المضخة الغاطسة الكهربائية (ESP) –الرفع بالغاز – تحليل الإنتاج – برنامج PROSPER– حقل انتصار سرت ليبيا

1. Introduction

Artificial lift used when reservoirs do not have enough energy for naturally produce oil to the surface or at the desired economic rate. It refers to the use of artificial means to increase the flow of liquids such as crude oil or water from a production well. The basic concept of artificial life is to add energy to the fluid column in a well bore, in order to create a predetermined bottom hole pressure so the reservoir may produce the objective flow rate. [1].Study in 2006 proved that gas lift method occupies 50% of artificial lift method, and ESP is sharing 30% of the total artificial lift method in the world. [2].The artificial lift method used when the reservoir pressure decreased and not produce at economic rate, the energy not able to raise the oil into the surface, but able to push the oil until the bottom hole of well. Electric submersible pump (ESP) the energy is transmitting down hole electrical by power cable. The gas lift (GL) external source of high-pressure gas that supplementing formation gas to reduce the bottomhole pressure (BHP) and lift the well fluids [3].

The process of selecting an ideal method for exploitation is complex and subjective. Different researchers can choose different methods using the same facts and information. There is however a process of thinking that everyone can follow to eliminate some subjectivity. Mehrdad Alemi, with a group of authors [4, 5, 6, and 7], dealt with the selection of artificial lift methods using several models of multicriteria analysis: TOPSIS, ELECTRE, SAW, and VIKOR, in the case of oil fields in Iran. The authors used multiple sets of input

تم استلام الورقة بتاريخ: 2 / 7/2023م وتم نشرها على الموقع بتاريخ: 31/ 7 /2023م

data: restrictions on production, deposits, and wells; characteristics of production fluid; and surface infrastructure.

The four primary artificial lift systems are[8]:

1- Electric submersible pump (ESP).
2- Gas lift.
3- Hydraulic pump (piston and jet pump).
4-Beam pump

The gas lift is a method of artificial lift that utilizes an external source of high-pressure gas to supplement formation gas to reduce the bottomhole pressure and lift the well fluids. Hydrocarbon production is the process by which an external fluid, such as water or gas, injected into the reservoir through injection wells located in rocks that have fluid communication with the production wells. Normally, gas injected into the gas cap and water injected into the production zone to sweep oil from the reservoir (edge of the reservoir). Gas may be inject continuously or intermittently, depending on the producing characteristics of the well and the arrangement of the gas-lift equipment. The amount of gas to be inject to maximize oil production varies based on well conditions and geometries. Too much or too little injected gas will result in less than maximum production. [9] The gas lift concept illustrated in figure 1.

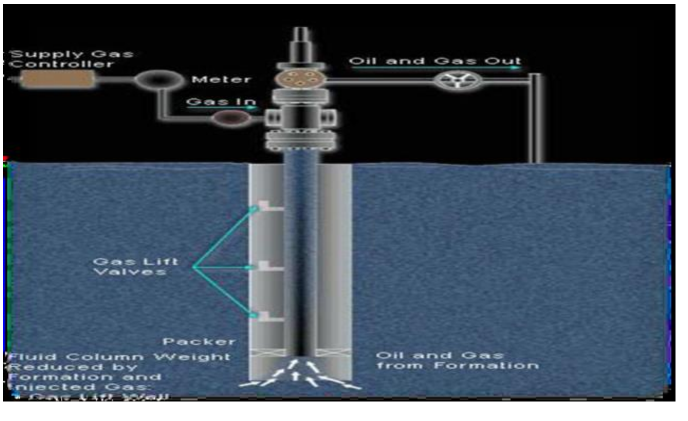


Figure 1.The gas lift concept [9].

تم استلام الورقة بتاريخ: 2 / 2023/7م وتم نشرها على الموقع بتاريخ:31/ 7 /2023م

The energy transmits downhole electrically by a power cable. The electrical energy transformed into mechanical energy by the submersible electric motor. When the ESP started, it draws the required voltage from the source. This powers the motor and thus generates pump rotation. Figure2 shows the ESP pump suction. [10]
As the fluid comes into the well through the perforation, it passes by the motor and into the pump. This fluid flowing past the motor brings about a natural cooling process that is critical for long and efficient motor life. The standard ESP-unit configuration requires the motor to be set above the perforations, allowing excess heat to dissipate in the produced fluid.
Set pump suction below perforation to maximize potential drawdown (increase production) and provide maximum area for gas separation. [11]

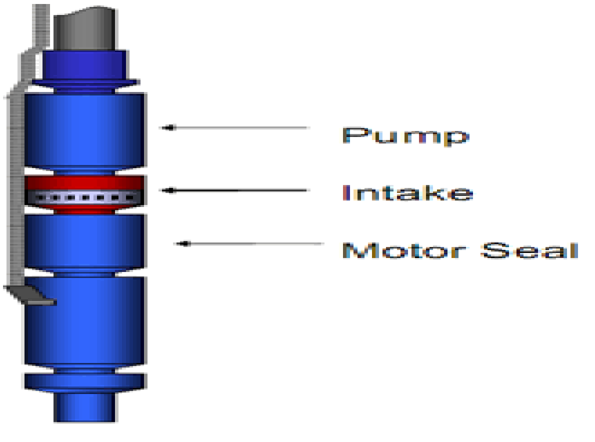


Figure 2.The ESP pump suction.[10]

2. The study's location.

About 260 kilometer south of Benghazi is where the 103E Field found in the Sirte Basin's concession 103. South of the field is where Well E 25 is located. 10,890 feet are in the depth of the well E-25. Figure 3 generated up to July 2013 when the well damaged by the excessive water rise.

تم استلام الورقة بتاريخ: 2 /7/2023م وتم نشرها على الموقع بتاريخ:31/ 7 /2023م

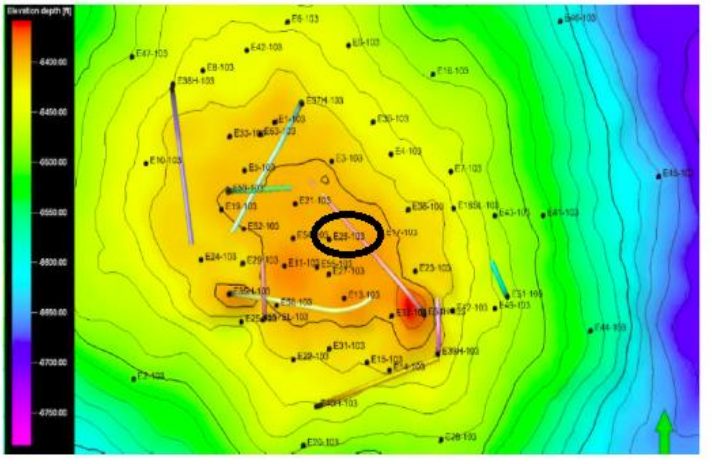


Figure 3.Well locations on top of depth structure map.

3. Objectives of the study

This study's objective is to increase flow rate by using one of the artificial lift techniques. Using Prosper software, (ESP/or gas lift) on a well in the E-25,103E oil field.

4. Materials and procedures

4 .1. The first action Analyze each piece of data that will be utilize in the study. Table (1, 2, 3, 4, and 5) contains data from the well (E 25, 103 E Field).

Table.1: IPR Data for well

Parameter	Quantity	Unit
Reservoir Pressure	3000	Psig
Reservoir Temperature	196	°F
Water Cut	70	%
S	-1.6	Dimensionless
K	11	Md
h(thickness)	94	Ft
Dietzshape factor	30	Dimensionless
A (drainage area)	1000	Acre

تم استلام الورقة بتاريخ: 2 /2023/7م وتم نشرها على الموقع بتاريخ:31/ 7 /2023م

Table 2: PVT Data of the Reservoir Fluid

Parameter	Quantity	Unit
GOR	185	scf/stb
Oil Gravity	34	API
Gas Gravity	0.75	Dimensionless
Water Salinity	189000	Ppm

Table 3: Deviation survey

Measured Depth ,ft	TVD ,ft
0	0
6804	6804

Table 4: Down hole Equipment

Parameter	Depth, ft
Tubing	6500
Casing	6804

Table 5: Geothermal Data

Depth ft	Temperature F
0	70
6804	196

4.2. PROSPER

After being used to increase a well's output, this program offers a solid forecast of its production characteristics. PROSPER also has the ability to improve (simulate) the flawed existing system; this is done by offering tools for evaluating each well's performance critically. The program enables the construction of well models that may take into account every factor, including well setup, fluid characteristics (PVT), multiphase VLP correlations, and different IPR models. By adjusting PVT, multiphase flow correlations, and IPR to match observed field data, PROSPER offers a special matching correlation that makes it possible to build a reliable model before applying it to prediction.[12]

Building the Well E25 Base Model in PROSPER as the First Step

تم استلام الورقة بتاريخ: 2 / 2023/7م وتم نشرها على الموقع بتاريخ:31/ 7 /2023م

In PROSPER; defining the system summary is the initial step in modeling a new well. The Black Oil model, which uses the oil and water choice to describe the fluid, employed, and the gas lift technique (a continuous kind of unloading) used, allowing for the filling in of data and design.
PVT enters data in step two.
Third step: IPR Data Entry Window
Fourth step: professional modeling
Fifth step: design pump and ESP data input
The sixth step is the evaluation of the ESP's performance under various.

5. Operation Conditions.

The intended ESP was put to the test in a variety of scenarios, including a drop in reservoir pressure, a rise in water cut, a change in wellhead pressure, a change in tubing size, a change in ESP operating frequency, and a change in the ESP pump's stage number. Changes in wellhead pressure and operation frequency have an impact, as shown in Tables 6 and 7. Because the pump setting depth was in the ideal range (Pr = 3000, WC percentage = 70), sensitivity was not required.

Table 6: Sensitivity for the first node pressure

Pwh, psig	Liquid rate, bbl/day	PHB, pisg
150	1050.5	1739.6
200	1023.6	1776.69
350	935.5	1893.59

Table 7: Sensitivity for the frequency

Frequency, Hz	Liquid rate, bbl/day	PHB, pisg
50	746	2143.27
60	999.5	1808.8
70	1232	1477.96

International Science and Technology Journal
المجلة الدولية للعلوم والتقنية

Volume32 العدد
Part 2 المجلد
July 2023 يوليو

المجلة الدولية للعلوم والتقنية
International Science and Technology Journal
ISTJ

تم استلام الورقة بتاريخ: 2 / 2023/7م وتم نشرها على الموقع بتاريخ:31/ 7 /2023م

6. Results and discussion:

6.1. The results of general data

The optimal functioning point for the ESP is show when the maximum and lowest values are 1266 bpd and 647 bpd, respectively. Figure 4. All computations in this study will be based on the assumptions that WC = 70% and Pr = 3000 pisg.

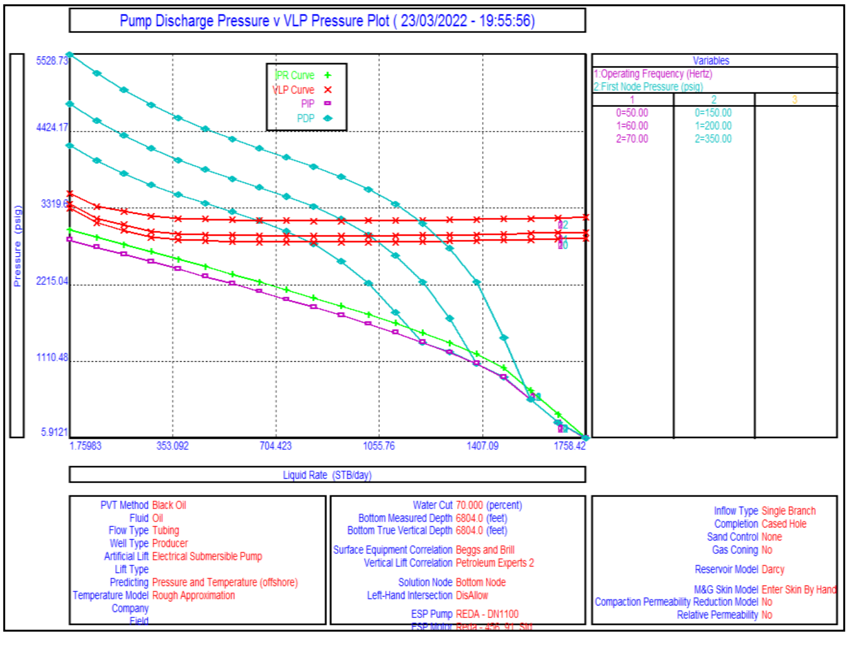


Figure 4: pump discharge pressure vs VLP Pressure plot.

6.1.2. The gas lift results of general data :

Gas lift style a number of factors must be included while modeling a gas lift well, especially for the well E25, as indicated in the accompanying figure (5, 6, 7, 8, 9, 10, 11, and 12).

تم استلام الورقة بتاريخ: 2 / 2023/7م وتم نشرها على الموقع بتاريخ: 31/ 7 /2023م

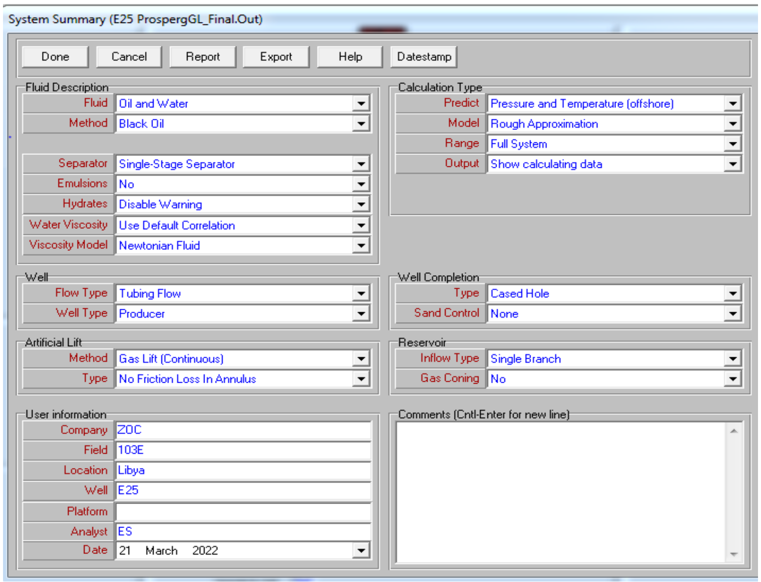


Figure 5: The PROSPER System Summary E-25 Prosperg

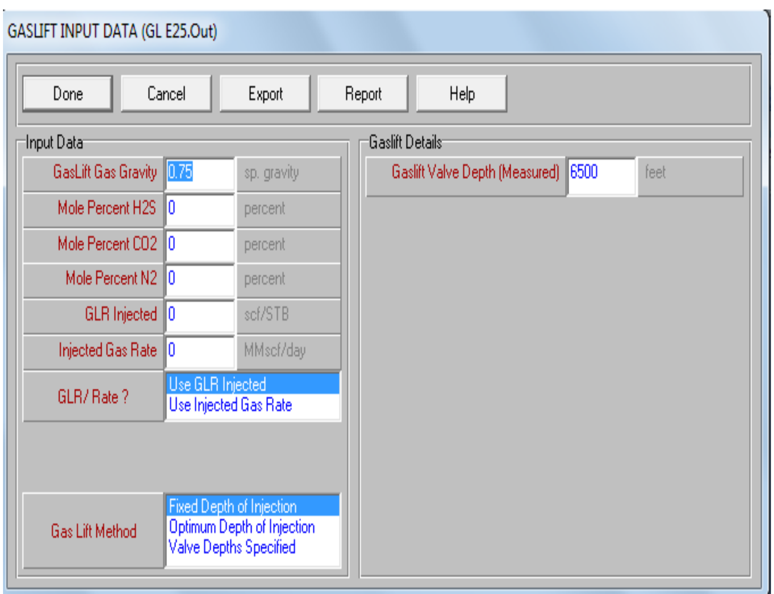


Figure 6. The input data for gas lift

International Science and Technology Journal
المجلة الدولية للعلوم والتقنية

Volume32 العدد
Part 2 المجلد
July 2023 يوليو

ISTJ المجلة الدولية للعلوم والتقنية International Science and Technology Journal

تم استلام الورقة بتاريخ: 2 / 7/2023م وتم نشرها على الموقع بتاريخ:31/ 7 /2023م

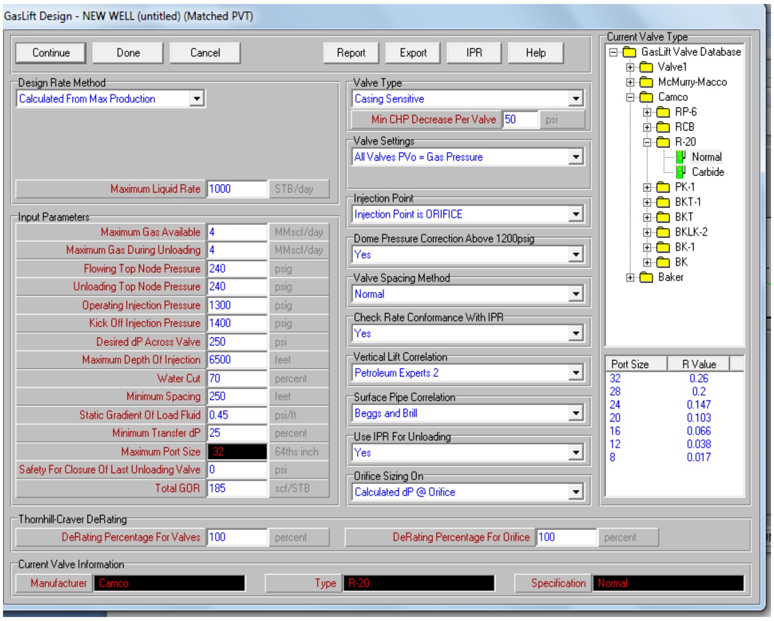


Figure 7. The Gas lift design input data

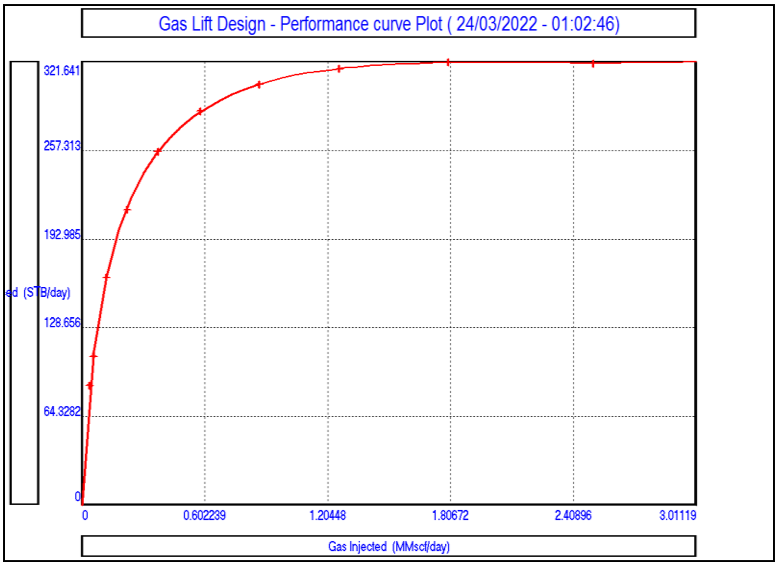


Figure 8. The gas lift design performance curve plot.

تم استلام الورقة بتاريخ: 2 /2023/7م   وتم نشرها على الموقع بتاريخ:31/ 7 /2023م

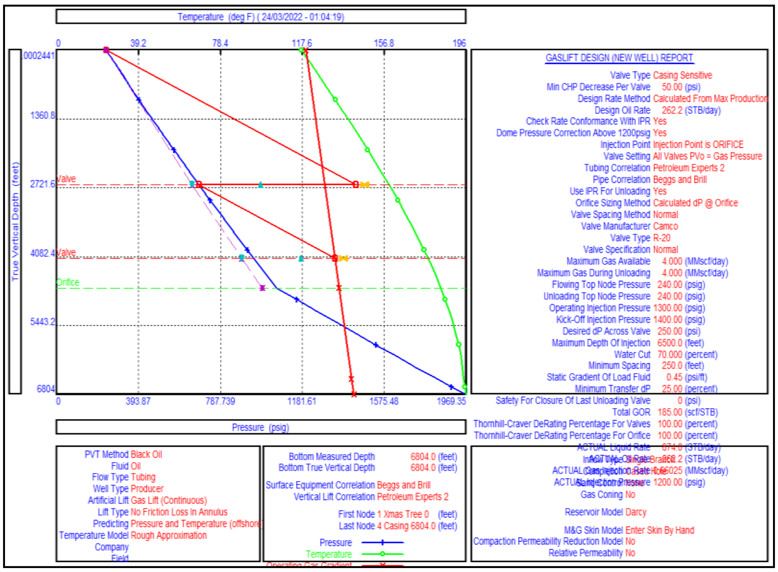
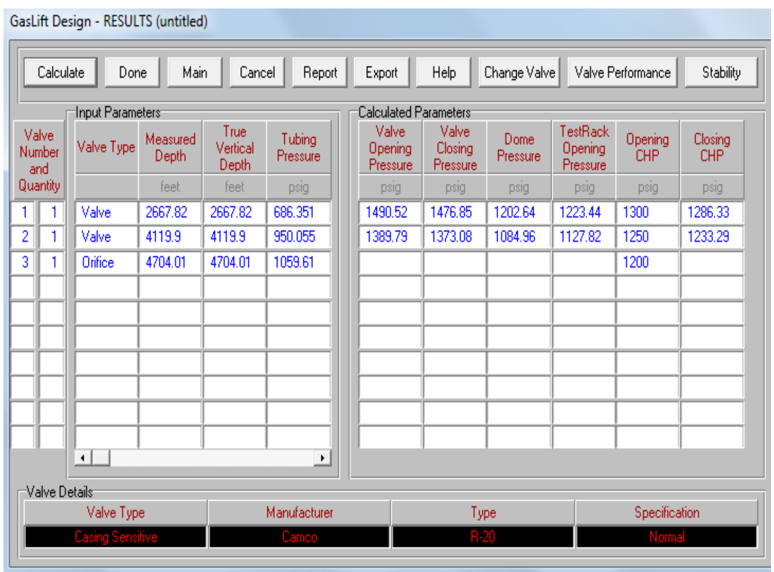


Figure 9: The Gas lift designed report



Valve Number and Quantity		Valve Type	Measured Depth (feet)	True Vertical Depth (feet)	Tubing Pressure (psig)	Valve Opening Pressure (psig)	Valve Closing Pressure (psig)	Dome Pressure (psig)	TestRack Opening Pressure (psig)	Opening CHP (psig)	Closing CHP (psig)
1	1	Valve	2667.82	2667.82	686.351	1490.52	1476.85	1202.64	1223.44	1300	1286.33
2	1	Valve	4119.9	4119.9	950.055	1389.79	1373.08	1084.96	1127.82	1250	1233.29
3	1	Orifice	4704.01	4704.01	1059.61					1200	

Valve Details

Valve Type	Manufacturer	Type	Specification
Casing Sensitive	Camco	R-20	Normal

Figure 10: Gas lift design results.

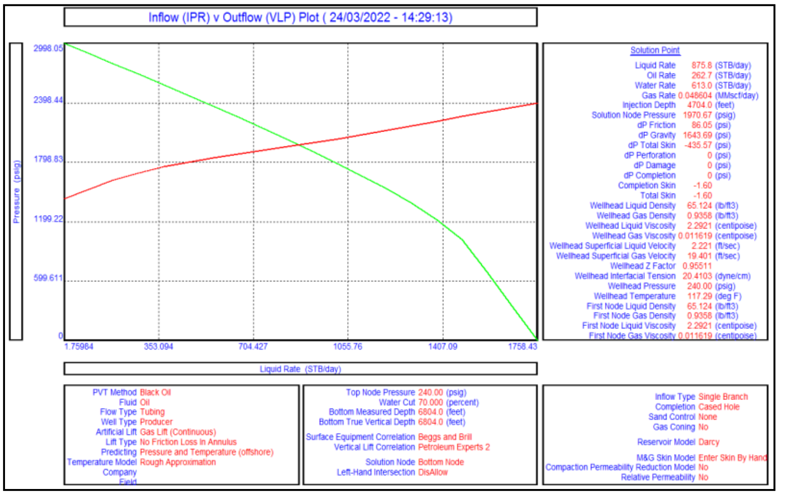


Figure 11: The inflow (IPR) vs out flow (VLP) Plot.

6.1.3 Gas Lift Sensitivities

The following parameters can be modified are related with inflow of the well. Thus, any alterations in these parameters will affect the IPR curve rather than VLP curve.

- Reservoir Pressure and Reservoir Temperature
- Productivity Index
- Water Cut
- Gas Oil Ratio (GOR), Water Oil Ration
- Dissolved and Free GLR

6.1.4. Gas injection rate sensitivity

By choosing the gas lift injection rate in system 3 variable 1, the lifting gas may be examined. Figure 12 shows the following curve as result of experiments with various injection rates on well E25, ranging from 0 to 3.5 MMscf/day:

According to this graph, a higher injection rate will result an increase in pressure as opposed to a change in the liquid rate (in this case, the rate of oil).According to the graph, the line tends to remain constant while gas is inject at a rate greater than 2.28 MMscf/day before decreasing after this rate and merely increasing pressure,

تم استلام الورقة بتاريخ: 2 / 2023/7م وتم نشرها على الموقع بتاريخ:31/ 7 /2023م

which might be unprofitable. As a result, 1.9886 MMscf/day is the well E25's maximum sensitivity. However, it is best to stay away from this rate because only pressure will increase, and probably more gas will be produce than liquid.

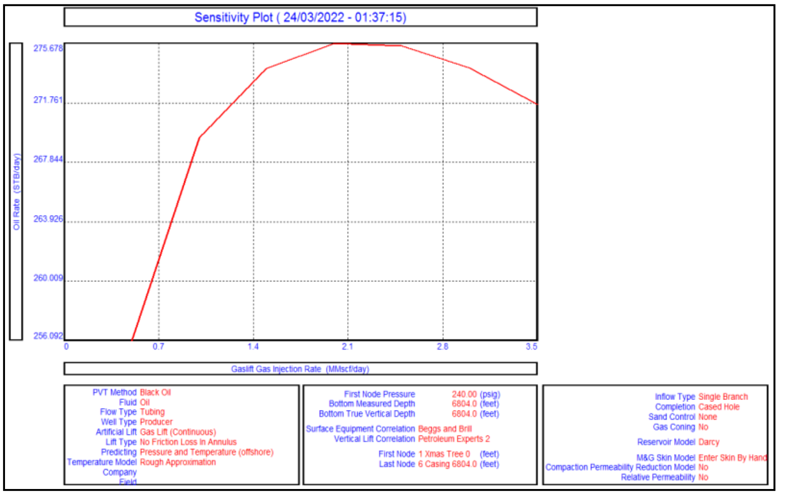


Figure 12 Gas lift injection rate sensitivity plot.

6.1.5. Gas liquid rate sensitivity

Selecting the injected GLR in the system of three variables' variable one allows for the analysis of various injected GLR. The graph below (Figure 13) is the result of testing various GORs, such as 500 SCF/STB and 3500 SCF/STB, on well E25.

6.1.6 Injection depth sensitivity

The oil or liquid rate rises as result of the deeper gas injection. A decrease in the density of the oil column inside the tube is what caused this to occur. The fluid will get lighter, which will lower the hydrostatic pressure. Thus, the PHB. Any gas lift system has a maximum injection depth that is just above the tube shoes when it comes to design consideration. The highest point here is 6500 feet.

International Science and Technology Journal
المجلة الدولية للعلوم والتقنية

Volume32 العدد
Part 2 المجلد
July 2023 يوليو

المجلّة الدّولية للعلوم والتقنية
International Science and Technology Journal
ISTJ

تم استلام الورقة بتاريخ: 2 / 2023/7م وتم نشرها على الموقع بتاريخ:31/ 7 /2023م

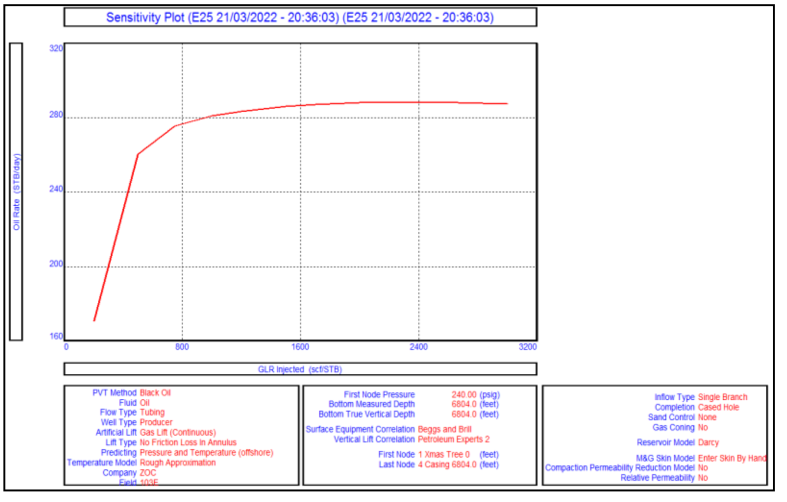


Figure 13.The Gas lift GLR Sensitivities plot

6.2. The Discussion

The well's operating point's liquid and oil flow rates, the well's absolute open flow (AOF), and the operating point's pressure drawdown The well's capacity to flow in the absence of formation damage and with less pressure drop in the various segments that led to pressure loss during production is known as the absolute open flow (AOF). While comparing the two artificial lift techniques, the natural flow had an AOF of 1700 stb/d. These suggest that the E25 well is capable of producing liquid at a rate of 1700 stb/d at zero pressure. The AOF production could not done practically since it is against pressure decrease, but it may be used as an example to demonstrate how the E25 well can be manage well. Reservoir and well pressure could lead to the achievement of production near AOF.

The operational point is when the inflow and outflow curves, which represent the flow from the reservoir to the wellbore and surface, respectively, converge. This statement describes well performance in terms of rate and the absence thereof, the wellbore drawdown. There is no natural flow in oil well E25. The performance curves of the two artificial lifts that were create to address this problem

تم استلام الورقة بتاريخ: 2 / 2023/7م وتم نشرها على الموقع بتاريخ:31/ 7 /2023م

compared in order to look for any deviations in the liquid/oil flow rate from the natural flow rate. The E25 well's ESP well performance curve, the graph shows that the operational point's liquid flow rate is 999.5 stb/d. The gaslift performance curve also shows that liquid flow rates are 875.5 stb/d.

7. Conclusions and recommendations

- Gas lifting is a simple method where little can go wrong, while ESPs are a complex solution.
- ESPs have a limited lifetime, which increases the cost of a project on the 103E field.
- Production through gas lifting is not only dependent on injection rate but can be optimizing through the completion design. Setting the valves deeper increases production.
- The production of the oil well E-25 shows that the ESP solution is superior to the gas lift. A secondary effect of the ESP pressure drawdown can also increase production and recovery factors for the field.
- The gas lift can give more fluid. If we have good management of the water injection, that will be maintain by the Pr constant and water cut, so we can get more benefit.
- The gas lift may be a choice. If we have a number of wells produced by gas lift, although they have a smaller rate than ESP, the cost will be lower than ESP.

Acknowledgment:
I would like to express my appreciation to Allah, researchers, contributors. Thank you for your support and engagement.

References

[1] Brown, Kermit E. The Technology of Artificial Lift Methods, Volumes 1, 2a, and 2b. Tulsa, OK: Penn Well Publishing Co. (1980).

تم استلام الورقة بتاريخ: 2 / 2023/7م وتم نشرها على الموقع بتاريخ:31/ 7 /2023م

[2] Lazim,S. (2018, January). Comparison between ESP and gas lift in the Buzurgan oil field in Iraq Journal of Engineering.

[3] Devine, D.L., Eads, P.T., Lea, J.F., and Winkler, H.W., Combination gas lift/ESP system increases flexibility," World Oil (October 1990).

[4] ELECTRE model. J. Pet. Sci. Eng. 2011, 78, 193–200. [Google Scholar] [CrossRef]

[5] Alemi, M.; Kalbasi, M.; Rashidi, F. A mathematical prediction based on SAW model. Middle East J. Sci. Res. 2013, 18, 1077–1082. [Google Scholar]

[6] Alemi, M.; Kalbasi, M.; Rashidi, F. A mathematical prediction based on VIKOR model. Middle East J. Sci. Res. 2013, 18, 1035–1041. [Google Scholar]

[7] Clegg, J.D.; Bucaram, S.M.; Hein, N.W. Recommendations and Comparisons for Selecting Artificial-Lift Methods (includes associated papers 28645 and 29092). J. Pet. Technol. 1993, 45, 1128–1167. [Google Scholar] [CrossRef]

[8] GáborTakács, 2009, "Electrical Submersible Pumps Manual: Design, Operations, and Maintenance", Gulf Professional Publishing, Elsevier, Oxford, UK.

[9] Maitelli, V. Bezerra, and W. Da Mata (2010, "Simulation of Flow in a Centrifugal Pump of ESP Systems Using Computational Fluid Dynamics", Brazilian Journal of Petroleum and Gas.

[10] WG Wood Group "Basic ESP Sizing Manual", 2007

[11] GáborTakács, 2009, "Electrical Submersible Pumps Manual: Design, Operations, and Maintenance", Gulf Professional Publishing, Elsevier, Oxford, UK.

[12] PROSPER v.10 User Manual, Petroleum Experts, 2008.